THE WAX-SECRETING ORGANS OF THE COCCIDÆ

BY G. F. FERRIS
Stanford University, California

The production of various kinds of secretions from modified hypodermal cells is an extremely common phenomenon among the insects. In literally thousands upon thousands of species such secretions occur in one form or another, sometimes being of such a nature and in such abundance as to form products of economic importance to man. Such substances as beeswax and shellac are of this origin.

In no group of insects, however, is this production of dermal secretions more conspicuous and of more general occurrence than among the scale insects. To be sure the members of this group share this phenomenon with other related groups such as the Aphidæ, Chermidæ, Aleyrodidæ and Fulgoridæ, but even so the extraordinary abundance of these secretions in many of the scale insects, the wide range of character and form under which they appear and the practical universality of occurrence among all the species of the Coccidæ, are elsewhere unapproached.

It is a curious fact that in spite of the conspicuousness of these secretions among the scale insects, there has been but little done in the way of detailed investigation of the structures from which the secretions originate. The occurrence in the derm of specialized structures connected with the elaboration of the secretions has long been known, and of recent years the importance of these purely cuticular structures in the systematic work upon the group has come slowly to be recognized. That the final development of a satisfactory classification of the group will involve a detailed knowledge and understanding of these structures is becoming increasingly apparent. Yet at the present time there exists no general study of even these cuticular structures, still less of the histological structures behind them.

In order to obtain a clear understanding of such structures as the various kinds of ducts and pores through which the secretions exude, no study merely of the derm as it appears in the

type of preparations that are used for systematic work will suffice. Such an understanding can only come when the histological structures that underlie these ducts and pores have been carefully investigated. The very curious misinterpretations of the pores and ducts, that frequently appear in our systematic work, show this very clearly. Yet at present the published information concerning the histology of the glands is extremely scanty and at times contains errors and misinterpretations that are no less curious than those to be found in purely systematic papers.

As a systematist interested in the development of a sound classification of the scale insects, and therefore realizing clearly the need of an understanding of these structures, I have long been interested in the histology of the glands. Some years ago I began the accumulation of histological material and the work was carried far enough to reveal a considerable body of fact and to show the existence of many errors in the small literature that deals with the subject. Press of other work has prevented the carrying of this study to the point where the publication of results could be justified. I have therefore initiated among my students a program of study of these glands, with the hope that finally there may be built up a sufficient body of information to permit the formulation of some general conclusions. The first short paper resulting from this work follows.

As an introduction to this series I am presenting herewith a bibliography of papers in which some contribution, as frequently erroneous as otherwise, to the literature of the wax-secreting glands occurs. In this list there are included only papers in which some information as to the histology of the glands is to be found. Papers dealing only with the ducts and pores in connection with systematic work are omitted. The bibliography is undoubtedly not complete, for there must be many passing references that have been overlooked, but it is believed to contain the more important contributions.

I would particularly call attention to the fact that these papers contain a large amount of error, in fact in but few of them are the conclusions and the figures presented to be

accepted unreservedly. The papers by Teodoro, alone, appear to present a trustworthy picture of the wax-secreting organs. As far as my own observations go, they agree closely with those of this author.

Bibliography of Papers on the Histology of the Wax-Secreting Organs of the Coccidæ

Berlese, A. Le Cocciniglie Italiane vivente sugli agrumi. Rivista di Patologia Vegetale, 2:70-109 and 129-187; pls. 3-5; numerous tf. *Ibid.* 3:49-163; pls. 2-13. (1894.) *Ibid.* 4:74-179; pls. 9-12, and 195-292; pls. 13-14. (1895-6.) *Ibid.* 5:1-61; pls. 1-12. (1896.)

Buffa, P. Sopra una cocciniglia nuova (*Aclerda berlesii*) vivente sulla canna comune (*Arundo donax*). Revista di Patologia vegetale, 6:135-159;pls. 4-6. (1898.)

Childs, Leroy. The anatomy of the Diaspinine scale insect *Epidiaspis piricola* (Del. Guer.). Annals Entomological Society America, 7:47-56; pls. 12-14. (1914.)

Ferris, G. F. The California species of mealy bugs. Stanford University Publications, University Series, p. 23. (1918.)

Fullaway, D. T. Description of a new Coccid species, *Ceroputo ambigua,* with notes on its life history and anatomy. Proceedings Davenport Academy Sciences, 12:223-240; 4 pls. (1910.)

Johnson, C. The internal anatomy of *Icerya purchasi.* Annals Entomological Society America, 5:383-388; pl. 28. (1912.)

List, J. *Orthezia cataphracta* Shaw. Eine Monographie. Zeitschrift für Wissenschaftliche Zoölogie 45:201-277; 6 pls. (1886.)

Matheson, R. The wax-secreting glands of *Pseudococcus citri* Risso. Annals Entomological Society America, 16:50-56. (1923.)

Mayer, P. Zur Kenntnis von *Coccus cacti.* Mitteilungen a. d. Zool. Stat. Neapel, 10. (1892.)

Moulton, Dudley. The Monterey Pine scale, *Physokermes insignicola.* (Craw.). Proceedings Davenport Academy Sciences, 12:1-25; 4 pls. (1907.)

Oguma, K. A new scale insect, *Xylococcus alni,* on alder, with special reference to its metamorphosis and anatomy. Journal College of Agriculture, Hokkaido Imperial University, Sapporo, Japan, 8:77-109; pls. 1-4. (1919.)

Putnam, J. D. Biological and other notes on Coccidæ. Proceedings Davenport Academy Sciences, 2:293-347; pls. 12-13. (1880.)

Teodoro, G. Le glandule ceripare della femmina della *Pulvinaria camelicola* Sign. Redia, 7:172-181; pl. 6. (1911.)

La secrezione della cera nei maschi della *Pulvinaria camelicola* Sign. Redia, 7:352-362; 4 tf. (1911.)

Le glandule laccipare e ceripare del *Lecanium oleæ* Bern. Redia, 8:312-320; 2 tf. (1912.)

Osservazione nella ecologia delle Cocciniglie con speciale riguardo alla morfologia e alla fisiologia di questi insetti. Redia, 11:129-207; 3 tf.; 3 pls. (1915.)

Cellule ipostigmatiche e cellule ceripare libere nel *Lecanium persicæ* Fab. Bulletino della Societá Entomologica Italiana, 50: 23-27. (1919.)

Le glandule ceripare de *"Ceroplastes sinensis"* Del Guer, e considerazioni generali su tali organi nei Coccidi. Bulletino della Societá Entomologica Italian, 53:37-41. (1921.)

Le glandule ceripare della *Filippia olea.* Redia, 15:177-179. (1924.)

Visart, O. Contribuzione allo studio delle glandule ceripare delle Cocciniglie (*Dactylopius citri* e *Ceroplastes rusci*). Revista di Patologia Vegetale, 3:39-47; pl. 1. (1894.)

Contribuzione allo studio delle glandule ceripare negli Afidi e nelle Cocciniglie. Bulletino della Societá Naturalisti Napoli, 8:112. (1895.)

Witlaczil, E. Zur Morphologie und Anatomie der Cocciden. Zeitschrift für Wissenschaftliche Zoölogie, 43:149-173. (1886.)

The Preparation of Histological Material of the Coccidæ

A rather extended experience in the preparation of histological material in this group has indicated that the best killing fluid is Carnoy's acetic alcohol; glacial acetic acid one part, absolute alcohol six parts, chloroform three parts. This fluid penetrates the waxy covering of the insects immediately, which many fluids will not do, and gives excellent fixation. Any of the commonly used hæmatoxylin stains such as Delafield's, Ehrhlich's or Hansen's, are suitable. Orange G as a counterstain is effective in picking out the chitinous, and sometimes extremely delicate, walls of ducts. Experiments have been made with intra-vitam staining and the use of dissection preparations to supplement sections but without any special advantage. I am inclined to suspect that some of the peculiar errors to be found in certain of the older papers have arisen because of the use of such preparations.